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**Higgins**

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(54) **NEURAL NETWORK NOISE ANOMALY  
RECOGNITION SYSTEM AND METHOD**

(75) **Inventor:** Robert C. Higgins, Tiverton, RI (US)

(73) **Assignee:** The United States of America as  
represented by the Secretary of the  
Navy, Washington, DC (US)

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706/25, 16**

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

5,583,968 A \* 12/1996 Trompf ..... 704/232  
5,683,425 A \* 11/1997 Hauptmann ..... 607/9  
2002/0023066 A1 \* 2/2002 Fu et al. .... 706/22  
2002/0029253 A1 \* 3/2002 Rhoads ..... 709/217  
2002/0173276 A1 \* 11/2002 Tschirk ..... 455/67.3

**OTHER PUBLICATIONS**

Ramamurti et al., "Neural Detectors for Signals in Non-Gaussian Noise", IEEE International Conference on Acoustics, Speech and Signal Processing, vol. 1 pp. 481-484, Apr. 1993.\*

Kim, M.W., "Gram-Charlier and Generalized Probabilistic Neural Networks Based Radar Target Detection in Non-Gaussian Noise", IEEE National Radar Conference, pp. 183-188, Mar. 1994.\*

Jim et al., "An Analysis of Noise in Recurrent Neural Networks: Convergence and Generalization", IEEE Transactions on Neural Networks, vol. 6, No. 6, 1996.\*

Al-Mashouq, K.A., "Noise Tolerance of Output-Coded Neural Net", Proceedings of the IEEE Digital Signal Processing Workshop, pp. 442-445, Sep. 1996.\*

Miguez et al., "Maximum Likelihood Blind Source Separation in Gaussian Noise", Proceedings of the 1999 IEEE Signal Processing Society Workshop, pp. 343-352, Aug. 1999.\*

Gandhi et al., "Neural Networks for Signal Detection in Non-Gaussian Noise", IEEE Transactions on Signal Processing, vol. 45 Iss. 11, pp. 2846-2851, Nov. 1997.\*

Yin et al., "Neural Filters: A Class of Filters Unifying FIR and Median Filters", IEEE International Conference on Acoustics, Speech and Signal Processing, vol. 4, pp. 53-56, Mar. 1992.\*

(List continued on next page.)

**Primary Examiner**—Wilbert L. Starks, Jr.

**Assistant Examiner**—Kelvin Booker

(74) **Attorney, Agent, or Firm**—James M. Kasischke;  
Michael F. Oglo; Jean-Paul A. Nasser

(57) **ABSTRACT**

A system and method for a neural network is disclosed that is trained to recognize noise characteristics or other types of interference and to determine when an input waveform deviates from learned noise characteristics. A plurality of neural networks is preferably provided, which each receives a plurality of samples of intervals or windows of the input waveform. Each of the neural networks produces an output based on whether an anomaly is detected with respect to the noise, which the neural network is trained to detect. The plurality of outputs of the neural networks is preferably applied to a decision aid for deciding whether the input waveform contains a non-noise component. The decision aid may include a database, a computational section and a decision module. The system and method may provide a preliminary processing of the input waveform and is used to recognize the particular noise rather than a non-noise signal.

**24 Claims, 1 Drawing Sheet**

